§49. Spatial Resolved High Energy Neutral Particle

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The time-of-flight neutral particle measurement system[1] with the capability of two-dimensional measurement has been installed on the 10-O port from the 2nd campaign. The sight lines of -2 to 32 degrees against the 10-O port surface makes the angle between the sight line and the magnetic axis of the standard configuration (3.6 m) of 95 to 35 degrees in 4th campaign. In this campaign, the higher scan speed of 0.17 degree/second than that in the last campaign (0.05 degree/s) can be obtained. Precise spatial distribution of the high energy particles can be expected because it enables the continuous scanning in the long discharge.

The pitch angular distribution of the high energy particles is studied in the ICH and NBI plasmas. The plasma stored energy of 200kJ can be produced by the application of NBI#2 and ICH against the seed plasma initiated by the ECH. The plasma is sustained during 1 second only by the ICH after stopping NBI#2 at 300ms. The angular distribution can be obtained by tilting of the analyzer shot-by-shot. The experimental conditions are as follows; the magnetic axis, the magnetic field and the density are 3.6m, 2.75T and 5x10-19 m-3, respectively. ICH of the power of 1.5MW is applied from two antennas set at 3.5U and 3.5L. It makes the resonance region around a/2 at the lower magnetic field side. Figure 1 shows the angular distributions with the parameters of energies at the phase in which the ICH and NBI#2 are applied at the same time. Each value is normalized by counts at 6 keV because each efficiency is different. The increase of the particle amounts is high at the region over 30 keV between 50 and 80 degrees. Figure 2 shows the angular distributions during the ICH phase in the same shots. Figure 3 shows the angular distribution the parameters of energies at the phase in which the NBI#1 and NBI#2 are applied on different shots but under the similar experimental condition. There are a few particles with larger pitch angle because NBIs are tangentially injected. In ICH phase, the peak in the angular distribution is observed around 70 degree especially at the high energy region. It is clear that the pitch angle of the particle accelerated by ICH is larger than that by NBI. It is confirmed by a simulation that the peak of the distribution in ICH plasma is at 70 degrees rather than at 90 degrees which is the accelerated direction by ICH.

The energy spectra are measured when the analyzer is continuously scanned in the long discharge. 120 seconds on ICH plasma can be succeeded in 4th campaign of LHD. In the experiment, the analyzer is scanned from 60 to 90 degrees during three 60 second discharges. The large amount particle at the high energy region can be detected when the sight line crosses the resonance area over 65 degree. The large amount particle at the energy range of lower than 6 keV is observed between 70 to 80 degrees. It is the trapped particle accelerated by ICH near the plasma edge. It is not observed in the NBI plasma. The result is in agreement with the simulation.

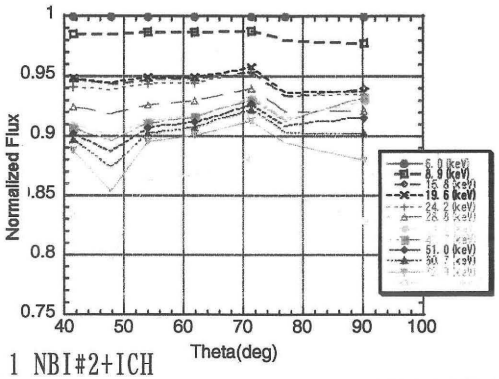

Fig. 1 NBI#2+ICH

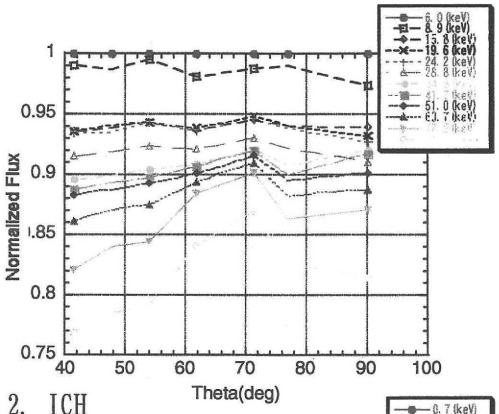

Fig. 2. ICH

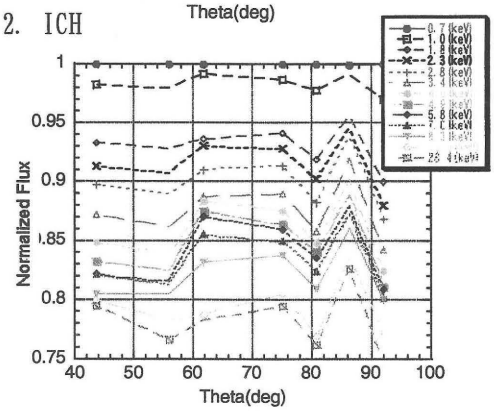

Fig. 3. NBI

1) Ozaki, T. et al., Rev. Sci. Instrum. 72, 7 (2000).